Proceedings SOFIA Upper Deck Science Opportunities Workshop, NASA Ames Research Center, Moffett Field, CA, June 22-23, 2004.

IN SITU METEOROLOGICAL AND TURBULENT MEASUREMENTS FOR THE SOFIA UPPER DECK

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ABSTRACT

We propose to integrate the NASA Ames airborne Meteorological Measurement System (MMS) on the SOFIA upper deck research facility to provide science quality *in situ* airborne meteorological parameters (pressure, temperature, turbulence, and three-dimensional wind vector).

INTRODUCTION

Accurate and fast meteorological measurements are indispensable for characterizing the atmospheric sampling environment. Dependable temperature and pressure data are needed to evaluate chemical reaction rates as well as to determine accurate mixing ratios. Accurate *in situ* measurement of pressure and temperature are particularly important for the microphysics, and they indirectly contribute to accurate determination of water vapor. Accurate wind field data establish a detailed relationship between the various constituents and the measured wind also verifies numerical models used to evaluate air mass origin. A reliable characterization of turbulence is important for understanding such processes as the impact of buoyant plumes on microphysics within cirrus clouds, the effect of breaking gravity waves on the diffusion of chemical species, and the drag exerted by the breaking gravity waves on the middle atmosphere. Airborne measurements provide detailed sampling of convectively generated gravity waves, whose momentum fluxes are important for the stratospheric momentum budget, and whose temperature variations have significant chemical and microphysical implications. The dynamical application of the MMS data cover broad range of atmospheric phenomena, including synoptic scale (polar vortex,), mesoscale scale (gravity waves, convective system) and small scale (turbulence, heat fluxes).

While most aircraft avionics systems also measure meteorological data, mainly for flight operations, these instruments are not PI-led and they lack the quality control and calibration required for scientific analysis. Aircraft wind data are also for navigational purpose and lack the vertical wind component, which is critical for atmospheric dynamical studies.

THE METEOROLOGICAL MEASUREMENT SYSTEM

The Meteorological Measurement System was developed at NASA Ames Research Center as a PI instrument to provide calibrated airborne state measurements. The instrumentation is optimized for specific fuselage to obtain science quality meteorological data. The MMS has operated successfully on the NASA DC-8, ER-2, and WB-57F. We are well positioned to undertake the proposed measurements research and development, because we are the only team that has successfully made these measurements on these platforms. The instrument team has extensive field experience having participated in STEP-1986, AAOE-1987, AASE-1989, AASEII-1991, SPADE-1992, ASHOE/MAESA-1994, STRAT-95, SUCCESS-1996, SONEX-1997, POLARIS-1997, CAMEX-3/4-1998/2001, SOLVE-2000, CRYSTAL-FACE-2002, and MidCix-2004. The team is within the Atmospheric Chemistry and Dynamics Branch at NASA Ames Research Center.

DELIVERABLES

Standard meteorological data will be presented in 1-Hz time series. For turbulence studies, higher frequency data is available, typically at 20-Hz and up to the 300-Hz of the sampling frequency. In the final archival data set, the MMS will provide measurements of time, pressure, temperature, wind vector (u, v, w), position (Differential GPS altitude, longitude, latitude), attitude (pitch, roll, heading), angle of attack, yaw angle, true airspeed, aircraft velocity (eastward, northward, vertical), vertical acceleration, Reynolds number, and turbulence intensity. After a thorough system calibration, we expect the following accuracy:

Pressure (p)	± 0.3 mb
Temperature (T)	± 0.3 K
Horizontal wind (u, v)	± 1 ms^{-1}
Vertical wind* (w)	< 1 ms^{-1} 0.1 ms^{-1} resolution
Local turbulence	up to 300-Hz data (limited by sensor response and sensor installation)

* The vertical wind in the calm air over a period of several minutes is assumed zero value on the average.

Acknowledgements: We acknowledge support from NASA's APRA program and NASA's Earth Science Enterprise to make the SOFIA Upper Deck Science Opportunities workshop possible.

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Manuscript received 2004 June 18; accepted 2004 June 18.